

## **PRESSURE VESSEL TESTING**

### **INTRODUCTION**

All pressure vessels and piping systems designed as per ANSI B31 codes to be used at Fermilab must be pressure tested to assure that they can be operated safely. ASME coded vessels which have not been modified do not have to be retested. When such testing is done on site, precautions shall be taken to minimize the risk of injury to persons and equipment in the test area. This chapter describes requirements for conducting and documenting pressure tests of room temperature pressure vessels (see definition Chapter 5031).

### **DEFINITIONS**

Qualified Person: A qualified person is "a person who, by possession of a recognized degree or certificate of professional standing, or who, by extensive knowledge, training and experience, has successfully demonstrated the ability to solve or resolve problems relating to the subject matter and work." The qualified person shall serve as the test coordinator.

### **SPECIAL RESPONSIBILITIES**

1. The qualified person responsible for the design, procurement or operation of the vessel shall:
  - a) Write the Engineering Note when require by Chapter 5031.
  - b) Prepare a "Pressure Testing Permit" and obtain all signatures prior to conducting the test.
  - c) Perform the pressure test.
  - d) Prepare a report on the pressure vessel test.
  - e) Submit a completed report for the ES&H Section Pressure Vessel Master File (MS119) to be attached to the appropriate Engineering Note.
2. The division/section safety officer or designee shall be responsible for:
  - a) Reviewing the system to assure all appropriate safety precautions have been taken, prior to commencement of the test.
  - b) Observing the test.

- c) Maintaining a file with a copy of the completed report.
3. The Mechanical Safety Subcommittee is available to advise and assist division/section personnel with pressure vessel testing.

## **REQUIREMENTS**

1. If an Engineering Note is required by Chapter 5031, it must be completed (minus the pressure testing requirement) prior to allowing a pressure test. A second, independent qualified person shall review, but not sign off on, the engineering note prior to conducting the pressure test.
2. Obtain a signed "Pressure Testing Permit" prior to conducting the test (see "Exhibit B").
3. The division/section safety officer or designee shall review the system under test and the surrounding area to assure all appropriate safety precautions have been taken, prior to the commencement of the test.
4. Pressure testing shall be performed as per ASME Sec VIII, UG-99 or UG-100 for pressure vessels or as per ASME/ANSI B31 code series for pressure piping. It is the responsibility of the design engineer to use hydrostatic or pneumatic pressure test values consistent with the latest revision of the applicable code.

As a guideline, the pneumatic test pressure shall be at least equal to 1.1 times the maximum allowable working pressure. Whereas, the hydrostatic test pressure shall be at least equal to 1.3 times the maximum allowable working pressure for vessels designed using ASME Sec VIII and 1.5 times the maximum allowable working pressure for piping systems designed using ASME/ANSI B31 code series.

5. All pressure tests shall be directed by a qualified person and observed by the division/section safety officer or designee.
6. A report shall be prepared for all pressure vessel tests by the qualified person. The report shall include the time, date, location, an equipment layout drawing, test data, conditions, personnel present and pressure readings. The layout shall show all system components and their pressure ratings. See attached "Exhibit A" for suggested set up for pressure testing, and also "Exhibit B" for test report format.
7. The completed report shall be filed with the Engineering Note in the ES&H Section Pressure Vessel Master File (MS119) and a copy maintained by the division/section.
8. A technical appendix which provides a detailed discussion of required documentation, safety precautions, equipment and materials, and test procedures is attached.

## **TECHNICAL APPENDIX TO PRESSURE VESSEL TESTING**

Requirements for hydrostatic and pneumatic pressure vessel testing are as follows:

### **1. SAFETY PRECAUTIONS FOR PRESSURE TESTING**

- a) Hydrostatic testing is considerably safer than pneumatic testing and should be used whenever possible.
- b) Testing should be done in an area set aside for the test with unnecessary persons kept away. This is especially important in pneumatic testing. All pressurized components shall be secured to prevent them from becoming missiles or whipping assemblies. Signs, lights, fences and barriers should be employed as needed to limit unauthorized access.
- c) The vessel support system shall be evaluated to ensure that vessel buckling will not occur during the hydrostatic test. The floor loading conditions also should be evaluated so as to safely transfer the vessel's weight and contents to the floor slab and the supporting grade.
- d) Prior to testing, the division/section safety officer or designee shall inspect the system to assure it conforms to the system layout drawing and that all appropriate safety precautions have been taken.

### **2. EQUIPMENT AND MATERIALS**

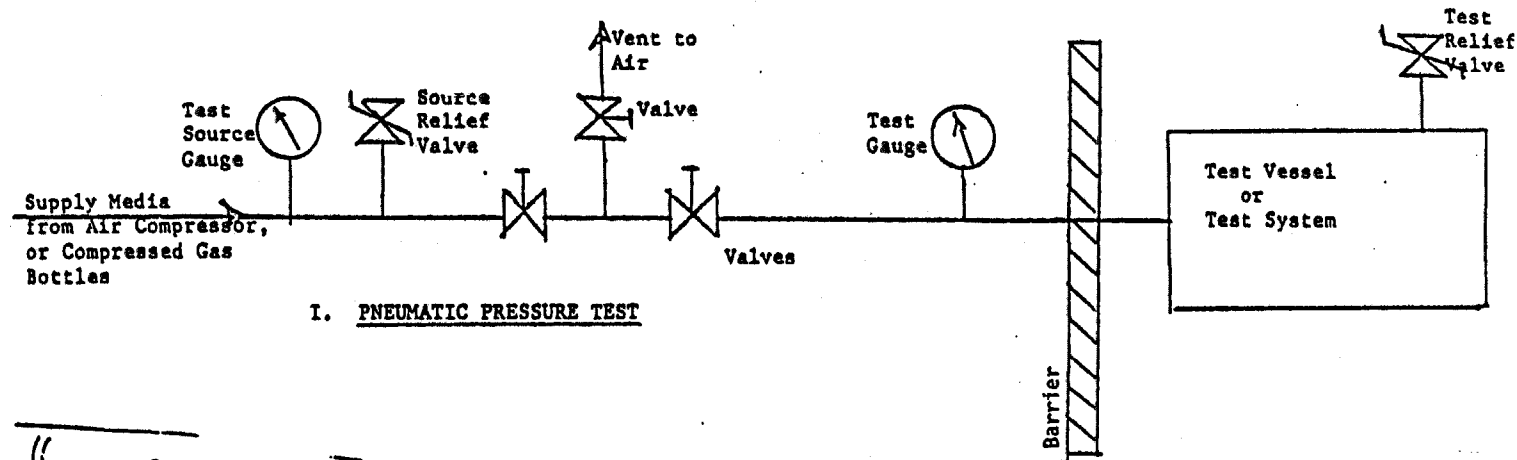
- a) The pressure test medium shall be inert. For hydrostatic testing, a nonhazardous liquid such as water shall be used at temperatures below 90°F and over 50°F to aid in avoiding condensation on the tank during the test. For pneumatic testing, an inert gas such as nitrogen or clean air (less than 50% RH) shall be used.
- b) Pressure test gauges should be of good quality, and shall have a full scale range of 1.5 to 4.0 times the intended maximum test pressure and be calibrated prior to each use. The gauge is to be accurate to within 4%. The gauge shall be connected directly to the vessel and shall be visible to the operator throughout the duration of the test.
- c) For hydrostatic tests, vents shall be provided at high points of the vessel in its test position to purge gas pockets during filling. A drain line with a valve capable of withstanding the test pressure shall be in place prior to filling the vessel. The manually operated valve shall be secured to a fitting at the lowest point of the vessel (flanged or threaded) and the drain line is to be connected to the outlet side of the valve.

- d) The pressure source shall have a relief valve of proper capacity and a set cracking pressure not greater than 110% of the maximum test pressure or the test pressure plus 3 psi, whichever is greater. The valve shall be tested for proper operation prior to conducting the test.
- e) The gaskets, O-rings, plugs, etc. may be reused if inspected and found to be acceptable by the qualified person.
- f) Test equipment should be used exclusively for pressure testing to avoid damage and contamination and should be placed in a secured storage area when not in use.

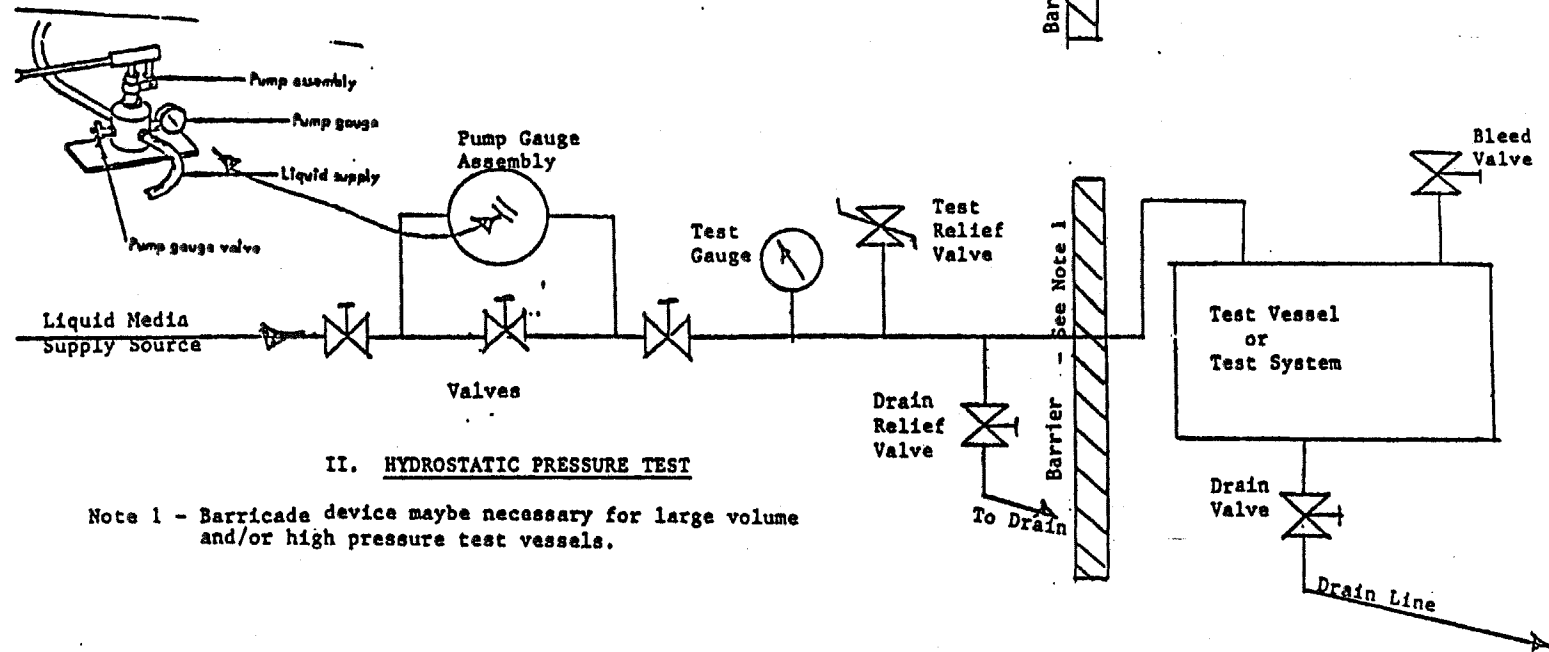
### **3. PRESSURE TEST GUIDELINES**

- a) Pressure testing should be conducted as per ASME Sec. VIII, UG-99 or UG-100 or as per ANSI B31 code series.
- b) All seams, connections of fittings, manways, plugs, couplings and welds made to the outside surface shall be visually examined in hydrostatic tests and soap-bubble checked in pneumatic tests. Helium leak testing may alternatively be used in pneumatic tests.
- c) If a leak is detected at any pressure level reading during the test, the pressure shall be immediately reduced to one-half that pressure level reading while locating the leak.
- d) If a leak is detected, the vessel and lines shall be depressurized before attempting any repairs or adjustments.
- e) If a pressure test is allowed to exceed the test pressure such that visible permanent distortion is encountered, or if visible permanent distortion in excess of the expected design amount is encountered without exceeding the maximum test pressure, the vessel shall be reviewed by the qualified person. Based on this recommendation, the vessel may be repaired, derated or scrapped.
- f) If a pressure test is allowed to exceed the test pressure but the vessel shows no measurable permanent deformation, the maximum allowable working pressure of that vessel need not be reduced. When this situation occurs, an engineering review shall be required before the vessel is accepted. This engineering review shall include a revised engineering note and a signed review of that note by a second qualified person.
- g) After inspection, the vessel shall be relieved of its pressure gradually through a valve at the test stand.
- h) For hydrostatic tests, the vents at the top of the vessel shall be opened after pressurization, the liquid media drained and the vessel dried to preclude excessive corrosion.

# SCHEMATIC SETUP FOR PRESSURE TEST EQUIPMENT



## I. PNEUMATIC PRESSURE TEST



## II. HYDROSTATIC PRESSURE TEST

Note 1 - Barricade device maybe necessary for large volume and/or high pressure test vassels.

EXHIBIT A



Fermilab

Date: \_\_\_\_\_

**EXHIBIT B**  
**Pressure Testing Permit\***

**Type of Test:**    ☐ Hydrostatic    ☐ Pneumatic

**Test Pressure**        \_\_\_\_\_ psig    **Maximum Allowable Working Pressure**        \_\_\_\_\_ psig

**Items to be Tested**

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**Location of Test**        \_\_\_\_\_ **Date and Time**        \_\_\_\_\_

**Hazards Involved**

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**Safety Precautions Taken**

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**Special Conditions or Requirements**

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**Qualified Person and Test Coordinator**

**Dept/Date**        \_\_\_\_\_

**Division/Section Safety Officer**

**Dept/Date**        \_\_\_\_\_

**Results**

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**Witness**        \_\_\_\_\_ **Dept/Date**        \_\_\_\_\_

(Safety Officer or Designee)

\* Must be signed by division/section safety officer prior to conducting test. It is the responsibility of the test coordinator to obtain signatures.